KEITH WELLER (K8396-10)

# Bringing You Better Beans

Beans and cornbread—a Saturday night staple in many parts of the country. But who really cares beans about this homely, low-cost food?

Well, many of us do. As Americans have become more health conscious, we've consumed more beans. Today, we eat almost 8 pounds per person each year. Pinto and navy beans account for 5 of those pounds, eaten mostly as refried beans (pintos) or as canned pork and beans (navy).

In all, U.S. growers harvested over 3 billion pounds of edible dried beans in 1998, worth over $600 million. But despite beans' familiarity and popularity, few of us are aware of the surprising amount of science to be found in an inexpensive can full of convenience and nutrition.

Key players in this science are the plant breeders who painstakingly work at developing new varieties with characteristics important to growers, processors, and consumers. North Dakota State and Michigan State universities have the two largest such programs in the country, both breeding varieties in all market classes of U.S. beans. But they are two of just a few bean breeding programs.

"We're lucky if there are a half-dozen centers in the United States," says Ken Grafton, a breeder at North Dakota State.

Nevertheless, in any large supermarket, shoppers should be able to count at least 10 different kinds of beans—known in the bean world as market

PEGGY GREB (K8793-1)

**Geneticist George Hosfield (left) and former research associate Clifford Beninger prepare bean extracts for analysis of phytochemicals and other nutrients using high pressure liquid chromatography.**

classes because each has its own distinct market and uses—small white, black, cranberry, dark-red kidney, great northern, light-red kidney, navy, pinto, small red, and yellow eye. Even smaller supermarkets will have close to 10—some of them in packaged mixtures, like a colorful, dry minestrone soup mix with small reds, great northerns, and light-red kidney beans.

**A Quarter Century of Research**

At the Bean and Beet Research Unit's Quality Laboratory in East Lansing, Michigan, Agricultural Research Service geneticist and breeder George L. Hosfield has been upgrading the color, canning quality, and other quality characteristics of beans—as well as their nutritional value—for the past 24 years.

If the small reds in that bag of minestrone mix are LeBaron Red, a variety recently released for the Pacific Northwest, they are the first upright small reds bred for superb canning quality and resistance to bean common mosaic virus, a major bean disease. Hosfield transferred the genes for erectness, canning quality, and virus resistance into red bean germplasm, which Phil Miklas, an ARS geneticist in Prosser, Washington, then used to create LeBaron.

LeBaron also has other desirable and unique characteristics for red beans. For one, it grows so quickly that farmers in certain areas can plant it after early-grown vegetables like peas for a second crop in the same season.

"LeBaron is part of the first wave of red beans emerging from Hosfield's germplasm," Miklas says. "Because of its unique disease resistance, exceptional seed appearance, and canning quality, I'll probably never release another small red variety without using germplasm that Hosfield developed," says Miklas. Smaller than kidney beans and shaped like pintos, 90 percent of red beans come from Washington and Idaho.

Prosser is one of four ARS centers for bean breeding research; the others are

## FLAVONOIDS: **The Unexpected Bean Ingredient**

People who pay attention to the colors of the foods they cook and serve are enhancing not only visual and gustatory pleasure, but nutritional punch as well.

Red grapes, oranges, pink grapefruit, strawberries, blueberries—all these foods contain colored pigments with nutritious cancer- and heart-disease-fighting compounds called flavonoids. These are the anti-aging antioxidants that may be responsible for the so-called "French paradox"—how the French tend to have fewer heart attacks and cancers, despite consuming high-fat diets. It's believed that the protective factor could be flavonoids in the skins of red grapes or the wine made from them. Flavonoids are also known to be in many other fruits and vegetables, as well as green and black teas and soy protein.

Now, Agricultural Research Service food quality geneticist and plant breeder George L. Hosfield has found these flavonoids in bean seed coats, which is where bean colors are also found. Certainly beans come in a mosaic of colors that can rival those of fruits and vegetables—from the plain white great northern and navy beans, to the mottled brownish pink pintos, to the cranberry bean's cream color with red streaks and flecks, the light and dark reds of kidney beans, the maroon-red adzuki, all the way to the black bean.

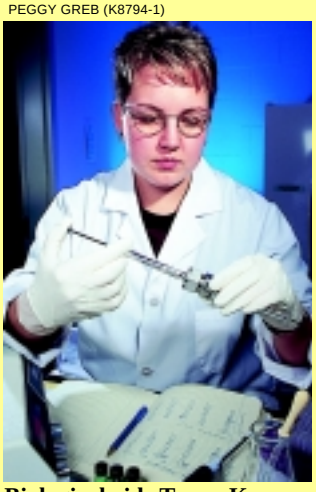
The bean industry has exacting standards for maintaining these colors. "It's so strict," says Hosfield, "that pinto beans, for example, have to not only have just the right brown mottling and shades of pink, but also show a yellow rim around the 'belly button,' or scar, where the bean was once attached to the pod.

"We know all eight genes that code for bean color, but we don't know how they work," Hosfield says. "Now we're trying to figure that out, as well as identify and learn the function of the genes for canning quality, disease resistance, and nutrition. And we're searching for links between these qualities and bean color."

The seed coat, which is 10 percent of the bean, is not only high in antioxidants for some beans, but is also where the high fiber content of beans comes into play.

It was Hosfield who found the antioxidants in the bean coat. He and colleagues removed the coating and made it into an extract, which they freeze-dried. Then they analyzed the constituents. They found eight flavonoids, six of which were particularly strong antioxidants. They also found a genetic link between bean color and the flavonoids. And they found a link between one flavonoid and resistance to bean mosaic disease. This is the first time a specific flavonoid association has been found with a bean color gene.

PEGGY GREB (K8794-1)



**Biological aide Tonya Kane prepares to perform an antioxidant assay.**

Using modern molecular genetic technology, pharmaceutical firms could mass-produce these flavonoids if they choose, adding beans to the growing list of foods used to make flavonoid supplements, now that Hosfield and colleagues have begun to break their genetic codes. Breeders could increase the amount of flavonoids in beans through traditional breeding or genetic engineering, or a combination.

Hosfield's work is inspiring other scientists to find ways to boost the high nutritional value of beans, possibly leading to even more iron, other vitamins and minerals, and antioxidants in the legumes. That's why Hosfield is excited about the high levels of antioxidants he's found in small red, red kidney, black beans, and pintos. And it's why he's passionate about the health benefits of eating beans and getting them the respect they deserve.—By **Don Comis,** ARS.

Now standard, the tests developed by ARS geneticist George Hosfield and Mark Uebersax of Michigan State University determine whether a potential new bean variety can keep its good qualities while being cooked, soaked in brine or broth, sealed in a can, and stored on grocery shelves.

in Maryland, Michigan, and Puerto Rico. Hosfield and three other geneticists from ARS—one at each center—develop germplasm that provides a good starting point for breeders. Their work provides important basics, like good yield, disease resistance, processing quality, and upright growing habits.

Shree Singh, a breeder who operates a bean nursery in red bean country at the University of Idaho, says that Hosfield's work is "of immense value to us. Hosfield is the only person working on bean quality, and he and Miklas are the only geneticists working on small red bean improvement—a neglected market class.

"Each of the four ARS geneticists does something very different," Singh says. "Their work is very complementary to ours, and they give us free germplasm that is not readily available, like that for improved small red beans.

"Private and public breeders throughout the United States and Canada send seeds of potential new varieties to my nursery for field-testing," says Singh. "I harvest new seed and send it to Hosfield, who then tests its canning qualities for me. Then I publish the results and share the information with public and private breeders. We are very fortunate to have this ARS support."

**But Can They Take the Heat?**

One of the most important attributes of any new bean variety is its suitability for processing.

"No one wants to open a can and find the beans mushy or split open, with starch leaching into the brine or tomato broth that they're packed in," Hosfield notes.

So in the 1980s, he and Mark A. Uebersax, of Michigan State University's Department of Food Science and Human Nutrition, devised a series of tests for beans. Now standard, the tests determine whether a potential new bean variety can keep its good qualities while being cooked, soaked in brine or broth, sealed in a can, and stored on grocery shelves. The tests simulate the exact conditions under which the bean must be cooked and canned to ensure consistent quality.

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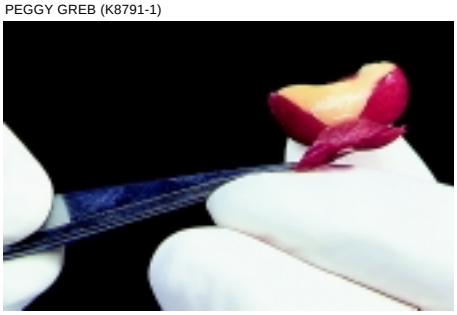

**The seed coat of the red kidney bean contains the color of the bean and is high in antioxidants.**

Breeders like Ken Grafton at North Dakota State University nervously await word from Hosfield about how a new bean holds up under high heat. He says the canning test is very important to breeders around the world.

"We can't tell by the plant's performance in the field how it's going to survive the process," Grafton says. "It's only at the canning stage that we find that out." By then, breeders have invested at least 3 years of work.

More likely than not, most of the canned bean varieties on grocery shelves were first evaluated at Hosfield's small-scale cannery in his lab. His tests are used to develop the two to four new dry bean varieties released each year by the Michigan State University/ARS breeding team, which is headed by MSU breeder Jim Kelly. All of the varieties released by the team have excellent canning qualities. Some of these varieties include Huron and Mackinac navy beans, Redhawk dark-red kidney beans, and—this year—Jaguar and Phantom black beans. The tests are models for other canning quality tests used nationally and internationally.

Now Hosfield has found molecular markers for some of the canning characteristics of navy beans. And he's searching for more markers that could help breeders eliminate some of the guesswork from the canning test—as well as improve beans' already high nutrient content and the plants' resistance to diseases.—By **Don Comis,** ARS.

*This research is part of New Uses, Quality, and Marketability of Plant and Animal Products, an ARS National Program (#306) described on the World Wide Web at http://www.nps.ars.usda.gov/programs/cppvs.htm.*

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